SILURIAN RUGOSE CORALS FROM THE MUMBIL AREA, CENTRAL NEW SOUTH WALES

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(Plates VIII–XII)

[Accepted for publication 19th June 1974]

Synopsis

Six species of rugose corals (three new) are described from strata of probable late Wenlock to early Ludlow age in the Mumbil area, near Wellington in central New South Wales. They comprise representatives of the genera *Holmophyllum* Wedekind, *Holmophyllia* Sytova, *Coronoruga* Strusz, *Pilophyllum* Wedekind and *Palaeophyllum* Billings. Several of the forms described from this area by Strusz (1961) are revised. The holotype of "*Baeophyllum*" *colligatum* Hill, 1940 is refigured and its affinities discussed.

Introduction

The first detailed study of the Palaeozoic strata of the Mumbil-Neurea-Dripstone area, some 24 km south-east of Wellington, was that of Strusz (1960). He defined a sequence consisting in the lower part of the Oakdale Formation of Upper Ordovician age, overlain by the Mumbil Formation, regarded as being Upper Llandovery to Ludlow in age. The Mumbil Formation was subdivided into a lower, Narragal Limestone Member, and upper, Barnby Hills Shales Member. Aspects of the coral fauna of this sequence were examined by Strusz (1961). Subsequent study of this region by Vandyke (1970, unpubl.), particularly in the region of the Oakdale Anticline (Text-fig. 1), has led to considerable reappraisal of the stratigraphic sequence and the age of the constituent formations (Vandyke and Byrnes, 1974). The Oakdale Formation is now elevated to group status and comprises a lower, Cypress Hill Volcanics and an upper, Mona Vale Siltstone (Vandyke and Byrnes, 1974). Unconformably overlying this is the Dripstone Group, consisting of the Wylinga Formation, Warderie Volcanics and Catombal Park Formation, in ascending stratigraphic order. The Dripstone Group is equivalent to the upper part of the former Oakdale Formation of Strusz (1960). Finally, the Mumbil Formation was also raised to group status and includes the Narragal Limestone and overlying Barnby Hills Shale.

The rugose corals described herein are represented in three horizons of the Dripstone and Mumbil Groups. From the Catombal Park Formation of the Oakdale Anticline *Palaeophyllum oakdalensis* sp. nov., *Holmophyllum struszi* sp. nov. and *Holmophyllia maculosa* sp. nov. are described. *P. oakdalensis* is particularly abundant in the calcareous beds at the base of this formation while the other two species are rare. The Narragal Limestone was divided in some places into an upper and lower member separated by a thin horizon of volcanic sandstone (Vandyke, 1970; Vandyke and Byrnes, 1974). From the upper

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member of this formation *Holmophyllia* cf. *simplex* (Lewis) is described, and *Coronoruga dripstonense* Strusz probably also comes from this upper member. *Pilophyllum multiseptatum* (Strusz) occurs in a limestone lens of the Barnby Hills Shale south of the Bell River (probably the lens marked as Loc. 7 in Text-fig. 1). This lens was regarded as equivalent to the Narragal Limestone by Strusz (1961) but was considered to overlie that formation by Vandyke (1970).

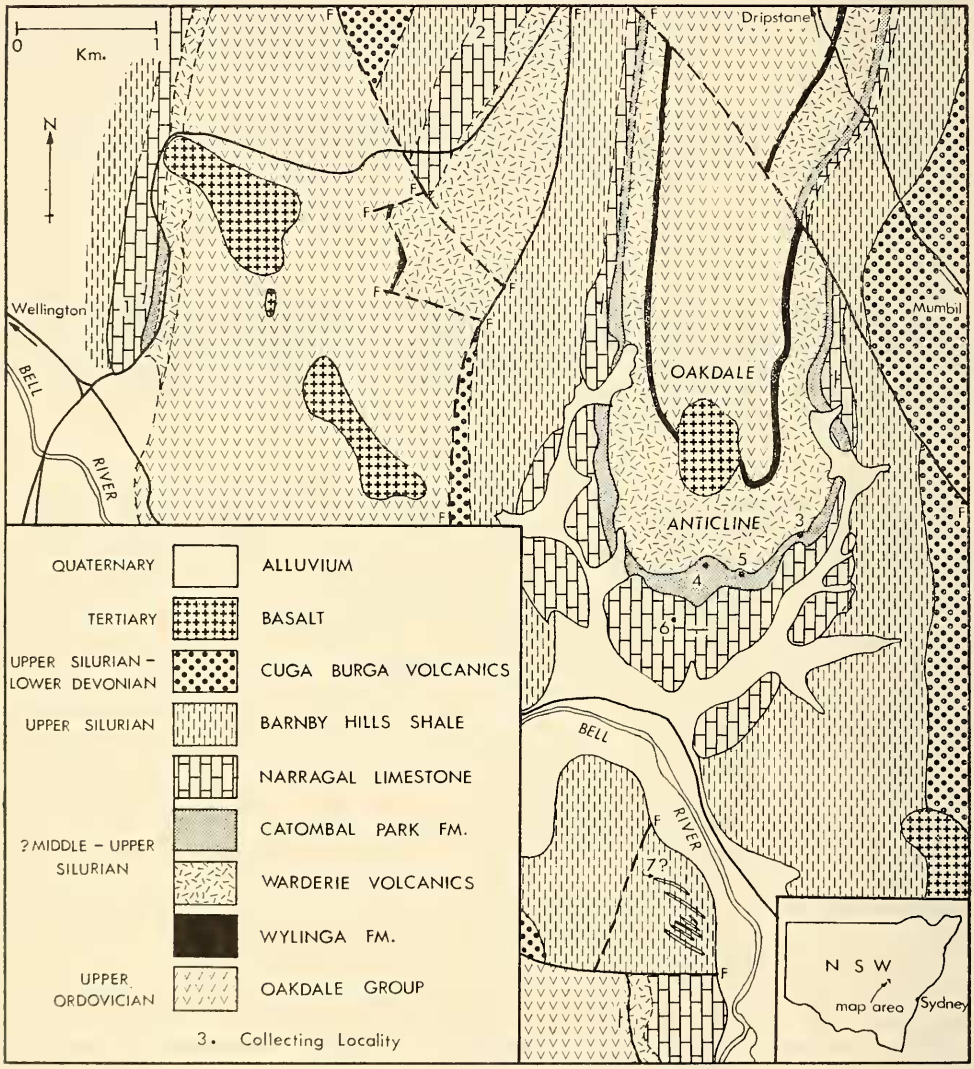

Fig. 1. Geological sketch map of the Mumbil area, showing collecting localities. Geology based on Vandyke (1970, unpubl.).

An unconformity between the Oakdale Group and Wylinga Formation was recognised by Vandyke (1970). In the Oakdale Anticline, shales with *Retiograptus* occur below the unconformity and, to the west, definite Ordovician graptolites and trilobites are found in shales of the Oakdale Group (Strusz, 1960, 1961; Vandyke, 1970; Webby, 1973). In the limestone lenses of the Wylinga Formation in the Oakdale Anticline, the rugosan *Rhizophyllum* is represented,

comprising forms showing similarities to those of the ?late Wenlock to Ludlow of the Yass District (see also Vandyke, 1970). This would suggest that the Llandovery and probably much of the Wenlock is missing in the sequence. The species of *Rhizophyllum* show no close similarities to the large from represented in the Upper Llandovery (Rosyth and Quarry Creek Limestones) of central New South Wales (McLean, 1974*b*).

From horizons low in the Barnby Hills Shale overlying the Narragal Limestone, abundant *Pristiograptus bohemicus* (Barrande) is represented (Strusz, 1960), together with rare *Neodiversograptus nilssoni* (Lapworth) (Vandyke, 1970 ; C. J. Jenkins, pers. comm., 1974). Hence the Narragal Limestone would not appear to range in age higher than the *nilssoni* zone (basal Ludlow). Therefore the Dripstone and Mumbil Groups as defined by Vandyke and Byrnes (1974) and the faunas described in this paper would appear to range most probably from late Wenlock to early Ludlow in age.

Specimen numbers in the University of Sydney Palaeontological Collections bear the prefix SUP and where more than one section has been prepared from the one specimen, they have the suffix a, b, etc. Numbers of specimens in the palaeontological collections of the Australian Museum, Sydney, have the prefix AM.F and thin sections in these collections bear the prefix AM.

Systematic Palaeontology

Family CYSTIPHYLLIDAE Edwards and Haime, 1850

Genus HOLMOPHYLLUM Wedekind, 1927

1927 *Holmophyllum* Wedekind, p. 31
1940 *Nipponophyllum* Sugiyama, p. 115
1940 *Baeophyllum* Hill, p. 403
1961 *Nipponophyllum* (*part.*) ; Strusz, p. 346
1963 *Nipponophyllum* (*part.*) ; Ivanovskiy, p. 112
non 1934 *Holmophyllum* ; Lewis, p. 95

For further synonymy see McLean, 1974*b*.

Type species. *H. holmi* Wedekind, 1927. Eke Beds (Ludlow), Gotland.

Diagnosis. Solitary or fasciculate corallum. Septa consist of discrete rhabdacanthine trabeculae piercing several dissepiments or tabulae. Tabularium generally clearly differentiated from peripheral zone of axially inclined dissepiments.

Discussion. The affinities and species composition of the genus *Holmophyllum* were reviewed by McLean (1974*b*). It was suggested in that paper that the branching form *Nipponophyllum* Sugiyama, 1940, was closely allied to *Holmophyllum*, but was tentatively separated from that genus on the basis of having more contiguous septal spines, particularly in the Tadzhikistan representatives of the genus. There is insufficient figured material of the type species of *Nipponophyllum*, *N. giganteum* Sugiyama, 1940, for detailed comparison but from what is available the septal spines would appear to be mainly discrete (Sugiyama, 1940, Pl. XXX, figs 3, 4 ; Text-fig. 3). The Australian genus *Baeophyllum* Hill, 1940 (regarded as a synonym of *Nipponophyllum* by most subsequent workers, e.g. Hill, 1956 ; Strusz, 1961 ; Ivanovskiy, 1963 ; Lavrusevich, 1967) was described as having both complete septa and discrete septal spines (Hill, 1940, p. 404). However, re-examination of the type material of *B. colligatum* Hill has shown no definite evidence of complete septa, although material is extensively recrystallised. Discrete septal spines may be sparsely seen and the holotype of the species (AM.F 9148) is re-illustrated herein for

comparison with other forms (Text-fig. 2 ; Pl. VIII, figs 1–5). Lavrusevich (1967) regarded *Nipponophyllum* as a branching form of *Holmophyllum* but it is felt that such a difference is probably not of generic importance. Hence both *Nipponophyllum* and *Baeophyllum* are here regarded as synonyms of *Holmophyllum*.

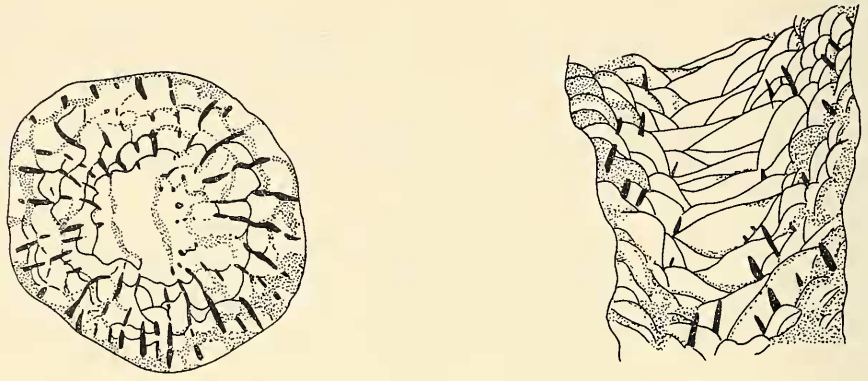

Fig. 2. *Holmophyllum colligatum* (Hill), Bowspring Limestone, Yass. a. AM704, holotype, transverse section, ×6. b. AM 704, holotype, longitudinal section, ×6.

The Tadzhikistan species of "*Nipponophyllum*" described by Lavrusevich (1967) are referred to *Holmophyllia* Sytova, 1970 (see below).

Species of *Holmophyllum* bearing a branching corallum (Group III of McLean, 1974*b*) are now taken to include *H. obscurum* Smelovskaya, *H. subtenuis* Shurygina, ?*H. primaevum* Wang, *H. giganteum* (Sugiyama), *H. colligatum* (Hill) and *H. struszi* sp. nov.

Holmophyllum struszi sp. nov.

Pl. VIII, figs 6–9, Pl. IX, figs 1–3 ; Text-fig. 3

1961 *Nipponophyllum* sp. cf. *giganteum* Sugiyama, 1940 ; Strusz, p. 347, Pl. 43, figs 3, 4 ; Pl. 45, fig. 12.

Derivation of name. After Dr. D. L. Strusz, who first worked on the coral faunas of the Mumbil area.

Material. Holotype SUP 74220, Paratypes SUP 10289, 40279 Catombal Park Formation, Oakdale Anticline, Mumbil area (Loc. 4). ?Late Wenlock.

Diagnosis. Corallum fasciculate or phaceloid. Septal spines stout, sparsely developed, of moderate length. Dissepiments large, strongly elongate ; tabulae complete and incomplete, widely spaced, in strongly sagging series.

Description. Corallum fasciculate or phaceloid, showing outgrowths of the dissepimentarium for support of adjacent corallites. Dimensions of corallum reach at least 27 cm high, with diameter of 25 cm. Increase is apparently calicinal. Corallites are closely spaced with diameter ranging from 9–12 mm in mature specimens.

Septal spines are rather stout, in 30–36 radial rows which are usually clearly defined. Spines are confined mainly to surface of dissepiments and are only rarely developed on tabulae. They generally pierce no more than 2–3 dissepi-

ments. Trabecular microstructure is obscured by recrystallisation (Pl. VIII, fig. 7).

Dissepiments are mainly strongly elongate, of very variable size although generally large, particularly at corallite periphery. They occur in 2–5 rows and are very steeply inclined towards axis of corallite. Tabulae are both complete and incomplete, very widely spaced and form strongly sagging series. Tabularium occupies approximately half of corallite diameter.

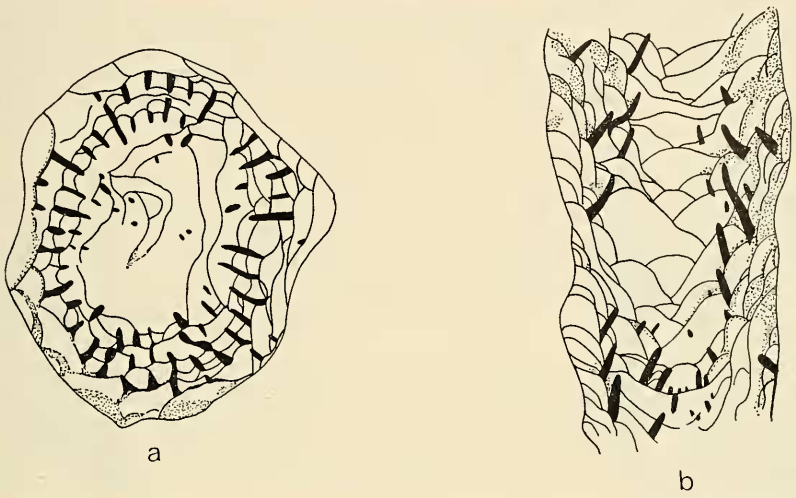

Fig. 3. *Holmophyllum struszi* sp. nov., Catombal Park Formation, Mumbil area. a. SUP 74220e, holotype, transverse section, ×4. b. SUP 74220h, holotype, longitudinal section, ×4.

Remarks. Strusz (1961) closely compared this form with *H. giganteum* (Sugiyama, 1940) from the Lower Ludlow of the Kitakami Mountains, Japan, the latter being type species of "*Nipponophyllum*". However, *H. giganteum* may be clearly distinguished by its larger number of septal spines and flatter, closer, more complete tabulae. It is felt therefore that the New South Wales form warrants erection of a new species.

H. colligatum (Hill, 1940) from the Bowspring Limestone (early or middle Ludlow) of Yass, New South Wales, is closely comparable to *H. struszi* in growth form but differs in having generally sparser, more irregularly developed septal spines, together with flatter more complete tabulae.

Genus HOLMOPHYLLIA Sytova, 1970

1934 *Holmophyllum*; Lewis, p. 95 (*non* Wedekind, 1927)

? 1952 *Holmophyllum* (*part.*); Bulvanker, p. 12

1967 *Nipponophyllum*; Lavrusevich, p. 18 (*non* Sugiyama, 1940)

? 1968 *Gukoviphyllum* Sytova, p. 54

1970 *Holmophyllia* Sytova, p. 68

? 1973 *Gukoviphyllum*; Fedorowski and Gorianov, p. 32

Type species. *Holmophyllia boreale* Sytova, 1970. Vaygach Horizon (Lower Devonian), Vaygach Island.

Diagnosis. Solitary or fasciculate corallum. Septa comprise rhabdacanthine trabeculae partly fused vertically near corallite periphery,

becoming discrete at their axial ends and in tabularium. Tabulae complete and incomplete, dissepiments very variable in shape and abundance.

Discussion. *Holmophyllia* is distinguished from *Holmophyllum* Wedekind on the basis of having its rhabdacanthine trabeculae partly fused vertically to give the impression of complete septa in the peripheral region of the corallite. This small difference could perhaps be regarded as of subgeneric importance only but it does appear to be a basic difference and so for the present full generic status for *Holmophyllia* is retained.

The similarities between *Gukoviphyllum* Sytova, 1968, and *Holmophyllum* and "*Nipponophyllum*" were discussed by McLean (1974*b*). In its long, partly fused septal spines *Gukoviphyllum* is also closely allied to *Holmophyllia*. However, according to Sytova (1968, p. 54; 1970, p. 68) the former lacks rhabdacanths, the trabeculae instead having a fan-shaped appearance, although this may be a feature of preservation. In all other respects, especially the fused spines, *Gukoviphyllum* appears identical to *Holmophyllia* (see *G. septatum*, Bulvanker, 1952, Pl. IV, figs 2–4; Sytova, 1968, Pl. I, fig. 5b; Fedorowski and Gorianov, 1973, Pl. VI, fig. 7b) and most probably *Holmophyllia* will prove to be a junior synonym of *Gukoviphyllum*. However, until the septal microstructure of *Gukoviphyllum* is illustrated and its synonymy with *Holmophyllia* confirmed or denied, it is felt that the latter genus should be retained for forms bearing definite rhabdacanths.

Holmophyllum simplex Lewis, 1934, from ? Wenlock pebbles in the Stack Series of the Isle of Man, has rather short rhabdacanthine trabeculae but these are clearly fused peripherally (Lewis, 1934, Pl. VIII, fig. a). The species is here regarded as a representative of *Holmophyllia*. Sytova (1970, p. 67) included it in *Gukoviphyllum*, but its definite rhabdacanths (Wang, 1947) would seem to preclude it from that genus.

The three species of "*Nipponophyllum*" (*N. turkestanicum*, *N. minimum* and *N. reimani*) described by Lavrusevich (1967) from the Upper Silurian of Tadzhikistan all exhibit partly fused, long rhabdacanthine trabeculae and hence are included here in *Holmophyllia*.

The following species are here regarded as representative of *Holmophyllia*: *H. boreale* Sytova (type species), *H. simplex* (Lewis), *H. turkestanicum* (Lavrusevich), *H. minimum* (Lavrusevich), *H. reimani* (Lavrusevich) and *H. maculosa* sp. nov.

Range. ? Wenlock of Isle of Man; ? Late Wenlock of New South Wales; Upper Silurian of Tadzhikistan; Lower Devonian of Vaygach Island. "*Gukoviphyllum*" is represented in the Pridoli of Podolia and late Ludlow-early Pridoli of Estonia.

Holmophyllia maculosa sp. nov.

Pl. IX, figs 4–7; Text-fig. 4

Derivation of name. Latin, *maculosus*=spotted, referring to appearance of tabularium due to septal spines in transverse section.

Material. Holotype SUP 40261. Catombal Park Formation, Oakdale Anticline, Mumbil area (Loc. 5). ? Late Wenlock. Collected by A. Byrnes, 1970.

Diagnosis. Corallum fasciculate. Septal spines partly fused vertically in peripheral regions of corallite, becoming discrete axially. Entirely discrete septal spines abundantly developed in tabularium. Dissepiments in narrow zone, elongate; tabulae closely spaced, forming strongly sagging series.

Description. Only one small fragment of a corallum was available for study. Growth form is fasciculate, the corallites quite widely spaced (average 5 mm). Corallite diameter ranges from 9–13 mm in mature stage.

Septa comprise long rhabdacanths, partly fused vertically in peripheral regions of corallite, becoming discrete at their axial ends. In inner parts of dissepimentarium, septal spines are entirely discrete, composed of broad rhabdacanths. In tabularium, spines are thinner and abundantly developed on tabularial crests. Spines pierce up to 8 dissepiments or tabulae. In transverse section well-defined radial rows of spines are evident with differentiation into major and minor septa. Minor septa consist mainly of one spine in a transverse section, extending 0·2–0·3 of length of major septa which are composed of several spines. Major septa, which range in number from 31–35, cannot usually be clearly traced far into tabularium, where they are replaced by an irregular cluster of spines (Text-fig. 4a ; Pl. IX, fig. 7). Minor septa are not always clearly apparent owing to extensive recrystallisation around most corallite margins.

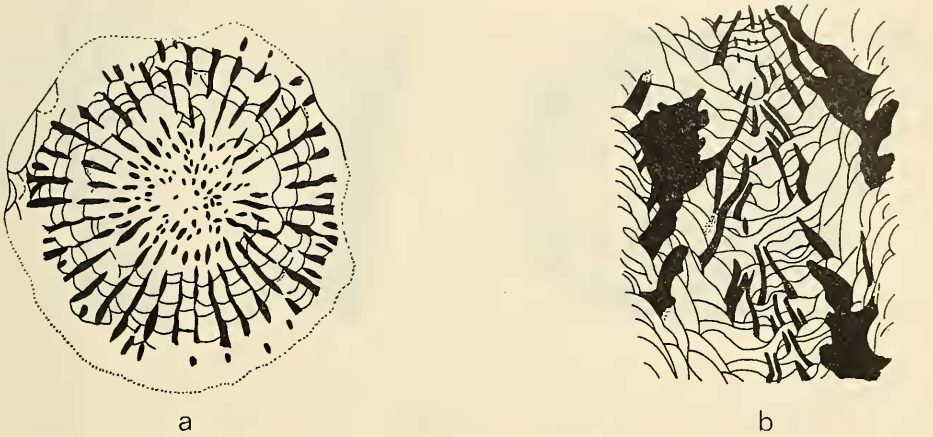

Fig. 4. *Holmophyllia maculosa* sp. nov., Catombal Park Formation, Mumbil area. a. SUP 40261a, holotype, transverse section, ×5. b. SUP 40261c, holotype, longitudinal section, ×5.

Dissepiments are weakly to strongly elongate, of moderate size and very steeply inclined to corallite axis. They occur generally in 2–3 rows. Tabulae are both complete and incomplete, occurring in strongly sagging series. Peripherally tabulae are widely spaced and steeply inclined to axis, becoming flat or weakly arched in axial region where they are very closely spaced.

Remarks. In its strong development of discrete septal spines in the tabularium and long major septa this species is comparable to the branching form *H. reimani* (Lavrusevich, 1967) from the Upper Silurian of the Turkestan Range of Tadzhikistan. However, the latter species may be distinguished by having fewer septa, longer minor septa and a very narrow tabularium.

Holmophyllia cf. *simplex* (Lewis, 1934)

Pl. IX, fig. 8 ; Pl. X, figs 1–7 ; Text-fig. 5

Material. SUP 39184, representing several corallites embedded in a stromatoporoid. Upper member of Narragal Limestone, Oakdale Anticline, Mumbil area (Loc. 6). Collected by A. Byrnes, 1970. SUP 74228, same horizon, western area of outcrop (Loc. 1). Late Wenlock or early Ludlow.

Diagnosis. Corallum solitary. Septal spines of short to moderate length, in partial lateral and vertical contact peripherally, forming distinct major and minor septa in late growth stages. Septal spines mainly discrete where based on dissepiments, but not developed in tabularium. Dissepiments small ; tabulae widely spaced, strongly sagging.

Description. Corallum appears to be solitary, growing commensally with a stromatoporoid. Corallites are subcylindrical with height at least 30 mm and diameter reaching 9 mm.

Septal spines are of short to moderate length, rhabdacanthine, dilated at corallite wall to be in lateral contact, forming a very narrow septal stereozone in some places. Spines are also partly fused vertically at corallite periphery (Pl. X, figs 2, 4) but where spines are based on dissepiments, which is uncommon, they are typically discrete.

It is rare for spines to extend through dissepimentarium to tabularium. Septa range in number from 46–50 in mature corallites, minor septa being 0·2–0·5 of length of major septa, the latter extending up to 0·6 of corallite radius. Minor septa do not appear to be developed until late in ontogeny.

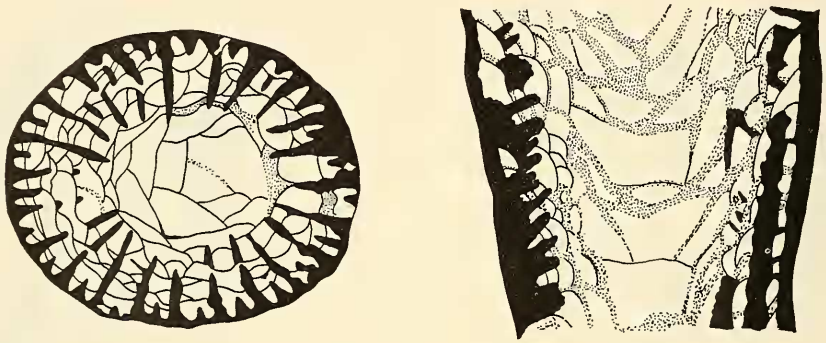

Fig. 5. *Holmophyllia* cf. *simplex* (Lewis), Narragal Limestone, Mumbil area. a. SUP 39184a, transverse section, ×7. b. SUP 39184c, longitudinal section, ×5.

Dissepiments are small, globose to weakly elongate, in 3–4 rows steeply inclined to corallite axis. Tabulae form very strongly sagging series, complete and incomplete, widely spaced.

Remarks. This form appears very closely similar to the ? Wenlock species *H. simplex* (Lewis, 1934) from the Stack Series, Isle of Man. The only difference would seem to be greater development of small, globose dissepiments at earlier growth stages in the New South Wales material. However, as only one figured longitudinal section of the type material is available (Lewis, 1934, Pl. VIII, fig. a), the New South Wales form cannot be more closely compared.

Genus CORONORUGA Strusz, 1961

1961 *Coronoruga* Strusz, p. 347

Type species. *C. dripstonense* Strusz, 1961. Narragal Limestone, Mumbil area. Late Wenlock or early Ludlow.

Diagnosis. (Based on Strusz, 1961, p. 347.) Large solitary corallites with a wide dissepimentarium separated from a rather narrow tabularium by a narrow stereozone in which are embedded short, discrete trabeculae.

Discussion. Ivanovskiy (1965*a*, *b*) suggested *Coronoruga* may be a synonym of *Gyalophyllum* Wedekind, 1927. However, the latter has coarse, very closely spaced septal spines almost completely occupying the space of the dissepimentarium whereas in *Coronoruga* the spines are largely confined to the stereozone separating the dissepimentarium and tabularium. The septal structure of *Coronoruga* with trabeculae, wrapped in lamellar sclerenchyme, occurring in layers on dissepiments and tabulae is comparable to that of *Angullophyllum*

McLean, 1974*b*, found in the Upper Llandovery of Angullong, central New South Wales. The latter differs in its smaller skeletal elements and compound growth form. *Coronoruga* appears to be endemic to Australia.

Coronoruga dripstonense Strusz, 1961

Pl. X, figs 8–10, Pl. XI, figs 1–3

1961 *Coronoruga dripstonense* Strusz, p. 348, Pl. 42, figs 9, 17

Material. Holotype SUP 11104, Paratypes SUP 11101, 11212–11215, 11195, 11198. Narragal Limestone, Mumbil area (Loc. 2). Late Wenlock or early Ludlow.

Diagnosis. See Strusz, 1961.

Description. See Strusz, 1961.

Remarks. From further sections made of the paratypes it is evident that where layers of sclerenchyme occur on dissepiments and tabulae, short septal spines are sparsely present although recrystallisation generally obscures this feature. The trabecular microstructure is largely also obscured by recrystallisation but it appears most probably to be rhabdacanthine, the individual trabeculae being wrapped in lamellar sclerenchyme.

Family ENDOPHYLLIDAE Torley, 1933

Genus PILOPHYLLUM Wedekind, 1927

1927 *Pilophyllum* Wedekind, p. 39
? 1937 *Sinospongophyllum* Yoh, p. 56
? 1942 *Sinospongophyllum* ; Hill, p. 20
1944 *Pilophyllum* ; Wang, p 23
1952 *Pilophyllum* ; Bulvanker, p. 20
1956 ? *Pilophyllum* ; Hill, p. F301
1961 *Nipponophyllum* (*part.*) ; Strusz, p. 346 (*non* Sugiyama, 1940)
1966 *Pilophyllum* (? *part.*) ; Sytova and Ulitina, p. 227
1968 *Pilophyllum* (*part.*) ; Lavrusevich, p. 110
non 1958 *Pilophyllum* ; Kaljo, p. 115
non 1960 *Pilophyllum* ; Zheltonogova, p. 77
non 1963 *Pilophyllum* ; Ivanovskiy, p. 60
non 1969 *Pilophyllum* ; Hill *et al.*, p. 5, 12.

Type species. P. keyserlingi Wedekind, 1927. Hemse Beds (Ludlow), Gotland.

Diagnosis. Solitary or fasciculate corallum. Septa thin, with well-defined stereozone on corallite wall and dissepimental surfaces. Dissepiments typically large, lonsdaleoid, sparsely developed. Tabulae incomplete, in arched series.

Discussion. The genus *Sinospongophyllum* Yoh, 1937, may well be synonymous with *Pilophyllum*. Hill (1942) considered the type species, *S. planotabulatum* Yoh, 1937 (Givetian, Kwangsi) differed from *Pilophyllum* in lacking greatly thickened septa and having more complete tabulae. However, from the illustrations of Wedekind (1927, Pl. 8, figs 1–6), the extent to which the septa of *Pilophyllum* are thickened in the stereozone is quite variable, that of *P. progressum* Wedekind being quite comparable to that of *S. planotabulatum* (Wedekind, 1927, Pl. 8, figs 5, 6 ; Yoh, 1937, Pl. VI, figs 2–5). The tabulae of *Sinospongophyllum* are certainly more complete than is evident in the Gotland specimens of *Pilophyllum* illustrated by Wedekind (1927) but this is probably not a significant generic difference. The material described below as *P. multiseptatum* (Strusz) has tabulae roughly intermediate in character between *P. keyserlingi* Wedekind (type species) and *S. planotabulatum*. Consequently *Sinospongophyllum* is herein tentatively regarded as a synonym of *Pilophyllum*. " *Sinospongo-*

phyllum" is also represented in the Lower Devonian of Queensland ("*S.*" *abrogatum* Hill, 1942, p. 20). Affinities of "*Sinospongophyllum*" with other Devonian forms have been reviewed by Hill and Jell (1970, p. 64).

Of Silurian genera, *Pilophyllum* shows perhaps closest similarities to *Kyphophyllum* Wedekind, 1927 (probably a synonym of *Strombodes* Schweigger, 1819—see McLean, 1974*a*). As pointed out by Merriam (1972, p. 37), *Pilophyllum* differs from "*Kyphophyllum*" in having a broader septal stereozone and sparser development of dissepiments, the latter tending to be larger than those of "*Kyphophyllum*". The type species of *Strombodes*, *S. stellaris* (Linnaeus) with its narrower dissepimentarium shows close similarities to *Pilophyllum* in longitudinal section (Smith, 1945, Pl. 29, fig. 2), but its lack of stereozone serves to distinguish it from *Pilophyllum*.

The genus *Pseudopilophyllum* was proposed by Lavrusevich (1971) for forms similar to *Pilophyllum* but differing in having numerous small dissepiments as opposed to the large, sparse dissepiments of *Pilophyllum*. It may be distinguished from *Pilophyllum* also by possessing thickened septa in the tabularium. "*Pilophyllum*" *moyeroense* Ivanovskiy, 1963, from the Upper Wenlock of the Siberian Platform was designated as type species of *Pseudopilophyllum* and the species is also represented in the Lower Wenlock (Horizon K) of Tadzhikistan (Lavrusevich, 1971, p. 69).

The three species of *Pilophyllum* described by Kaljo (1958) from the late Ordovician-early Silurian of Estonia (*P. porosum*, *P. zonatum* and *P. massivum*) all possess an axial structure and thus would not appear to be representative of that genus. This has been recognised also by Sytova and Ulitina (1966, p. 227) and Lavrusevich (1968, p. 110). Ivanovskiy (1965*b*) has listed these three species as possible representatives of *Paliphyllum* Soshkina.

Zheltonogova (1960) described two species of *Pilophyllum* (*P. insolitum* and *P. angustum*) from the Tom-Chumysh Beds (Lower Devonian) of the Salair, south-west Siberia. Both these forms require further study but do not appear to be representative of *Pilophyllum* as suggested by Sytova and Ulitina (1966, p. 228) and Hill (1967, p. 668). "*P.*" *insolitum* possesses numerous dissepiments and "*P.*" *angustum*, while appearing rather similar to *Pilophyllum* in longitudinal section (Zheltonogova, 1960, Pl. S–18, fig. 1), does not appear to have clearly developed lonsdaleoid septa and has been referred to the new genus *Salairophyllum* by Besprozvannykh (1968).

P. bimurum Sytova *in* Sytova and Ulitina, 1966, from the Lower Devonian Nadaynasuy Horizon of Kazakhstan differs from typical *Pilophyllum* in having an "inner wall" of thickened septa. However, in all other respects it appears closely similar to that genus.

The form illustrated by Hill *et al.* (1969, Pl. SVI, fig. 9) as *Pilophyllum* sp. from the upper part of the Jack Limestone Member of the Graveyard Creek Formation, Broken River, North Queensland (?. M.-U. Silurian, Hill *et al.*, 1969, p.s 12) differs from *Pilophyllum* in lacking a septal stereozone and having a very pronounced axial vortex. It may be congeneric with a form described as *Tabulophyllum*? *lowryi* Hill and Jell, 1970, from the Upper Devonian Napier Formation of the Canning Basin, Western Australia. As mentioned by Hill and Jell (1970, p. 66) this latter form probably represents a new genus.

The species composition of *Pilophyllum* is here taken to be: *P. keyserlingi* Wedekind, *P. munthei* Wedekind, *P. sayuhoense* Wang and *P. multiseptatum* (Strusz). Doubtfully included in the genus are *P. bimurum* Sytova, "*Sinospongophyllum*" *planotabulatum* Yoh and "*S.*" *abrogatum* Hill.

Range. Wenlock of China; Ludlow of Gotland, Podolia and New South Wales; Upper Silurian of Tadzhikistan and Kazakhstan; Lower Devonian of ? Kazakhstan and ? Queensland; Middle Devonian of ? China.

Pilophyllum multiseptatum (Strusz, 1961)

Pl. XI, figs 4–6 ; Pl. XII, figs 1–3 ; Text-fig. 6

1961 *Nipponophyllum multiseptatum* Strusz, p. 346, Pl. 44, fig. 12 ; Pl. 45, fig. 9.

Material. Holotype SUP 11099, limestone lens in Barnby Hills Shale, south of Bell River (Loc. 7 ?). Early Ludlow.

Diagnosis. Fasciculate *Pilophyllum* with well developed peripheral stereozone, dissepiments weakly developed and only late in ontogeny and tabulae differentiated into axial and periaxial series.

Description. Corallum fasciculate with lateral increase. Corallites subcylindrical with deep, steep-sided calice. Diameter of corallites ranges commonly from 12–14 mm.

Septal number ranges up to 64 in mature corallites with all septa set in a stereozone of lamellar sclerenchyme up to 1·5 mm wide. Sclerenchyme occurs thickly on corallite wall and to a lesser extent on the dissepimental surfaces (Pl. XI, fig. 5). Major septa are thin, extending 0·6–0·7 of corallite radius, interrupted peripherally late in ontogeny by lonsdaleoid dissepiments. Minor septa are up to 0·5 of length of major septa, generally not extending far beyond stereozone on corallite wall or dissepimental surfaces. They may show weak separation of trabeculae at their inner margins.

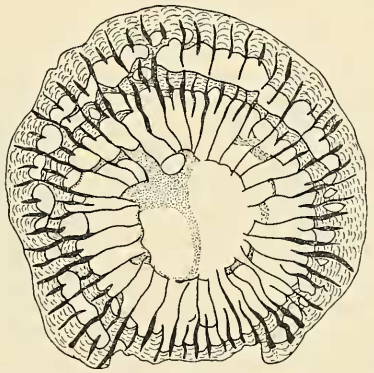

Fig. 6. *Pilophyllum multiseptatum* (Strusz), limestone lens in Barnby Hills Shale, Mumbil area. SUP 11099, holotype, transverse section, ×4.

Dissepiments are lacking in early growth stages, septa extending uninterrupted from corallite wall (Pl. XI, fig. 4 ; Pl. XII, fig. 3). In late ontogeny, dissepiments developed in 1–2 rows, large, strongly elongate and steeply inclined with marked sclerenchymal coating. Tabularium width is approximately 0·7 of corallite diameter. Tabulae occur in two series : an outer, distally inclined series comprising closely spaced, incomplete tabulae and an axial series of widely spaced, mainly flat, complete tabulae.

Remarks. This form was originally included in the genus *Nipponophyllum* Sugiyama, 1940, by Strusz (1961) but differs from that genus in lacking discrete septal spines. Further thin sections prepared from the holotype material have confirmed the lamellar character of the septa. Unfortunately the longitudinal section of the holotype figured by Strusz (1961, Pl. 44, fig. 12) has been partially destroyed but an additional section figured herein (Pl. XII, fig. 2), although not as well oriented, confirms the character of the tabulae and dissepiments. The material listed as a paratype of this species (SUP 10299, Strusz, 1961, p. 346) is of a poorly preserved carinate form and would not appear to be conspecific with the above described species.

P. multiseptatum shows perhaps closest internal similarities to *P. weissermeli* Wedekind, 1927 (?=*P. keyserlingi*), from the Klinteberg Beds (Upper Wenlock-Lower Ludlow) of Gotland and Akkan Horizon (Upper Silurian) of Kazakhstan (Wedekind, 1927 ; Sytova and Ulitina, 1966). *P. multiseptatum* may be distinguished however, by its much smaller size, broader stereozone on the corallite wall and differentiation of the tabulae into two series.

P. multiseptatum also shows similarities to the type species of " *Sinospongophyllum* ", " *S.* " *planotabulatum* Yoh, 1937, from the Middle Devonian of China. Particularly comparable are the degree of peripheral septal thickening and the complete tabulae in the axial region. However, " *S.* " *planotabulatum* is a much larger, solitary form and has less development of peripheral, incomplete tabulae, the axial complete tabulae being more closely spaced.

Family STAURIIDAE Edwards and Haime, 1850

Genus PALAEOPHYLLUM Billings, 1858

1969 *Palaeophyllum* ; Ivanovskiy, p. 80 (*cum syn.*)
1972 *Palaeophyllum* ; Webby, p. 151
1972 *Palaeophyllum* ; Merriam, p. 29

Type species. *P. rugosum* Billings, 1858. Lake St. John, Little Discharge, Quebec. Black River or early Trenton.

Diagnosis. (Modified from Hill, 1961, p. 4.) Corallum phacelo-cerioid. Corallites have narrow peripheral stereozone and lack dissepiments. Major septa are long and thin and minor septa are generally short. Tabulae are thin, commonly complete and arched, sometimes with axial depression.

Discussion. Ivanovskiy (1969) proposed that the known species of *Palaeophyllum* could be grouped into three broadly defined species : *P. thomi* (Hall, 1857) ; *P. fasciculum* (Kutorga, 1837) and *P. lebediensis* (Tcherepnina, 1960). The writer agrees with Webby (1972) that these three " species " may be better considered as species groups (or ? subgenera). *P. oakdalensis* sp. nov. described below, with well-developed minor septa and flattened tabulae, is representative of the *P. fasciculum* group, as suggested by Webby (1972).

Range. Lower Caradoc of Scotland, North America and New South Wales ; Upper Caradoc of North America, ? Urals and ? south-west Siberia ; Ashgill of Norway, Estonia, Urals, Siberian Platform, south-west Siberia, North America and ? China ; Lower Llandovery of Estonia, Urals, Siberian Platform and ? North America ; Upper Llandovery of Norway, Greenland and ? Siberian Platform ; ? Late Wenlock of New South Wales ; Late Wenlock-Ludlow of New York ; Ludlow of ? California.

Palaeophyllum oakdalensis sp. nov.

Pl. XII, figs 4–8 ; Text-fig. 7

1961 *Palaeophyllum rugosum* Billings ; Strusz, p. 341, Pl. 42, figs 7, 8, 15 ; Text-fig. 3.

Derivation of name. After the property of " Oakdale ".

Material. Holotype SUP 74229 Catombal Park Formation, Oakdale Anticline, Mumbil area (Loc. 3). Paratypes SUP 10240, 10244–10246, 10248–10250, 74230–74235. Same horizon, Locs 3, 4, 5. ? Late Wenlock.

Diagnosis. *Palaeophyllum* with average corallite diameter 7 mm. Major septa extend to nearly 0·8 of corallite radius at maturity, minor septa generally 0·4 length of major septa. Peripheral stereozone well developed and major septa average 20 in number. Tabulae range in shape from flat to strongly arched, with gently arched types most common ; spacing very variable.

Description. Corallum phaceloid. Increase is calicinal and parricidal, with four offsets from the one corallite being most common (Pl. XII, fig. 8). Possible lateral budding is also represented. Corallite diameter ranges from 6·5–8 mm in mature specimens with an average of 7 mm. Septa are of two orders, set in a narrow but clearly developed peripheral stereozone of lamellar sclerenchyme. This stereozone averages 0·1 of radius of corallite. Major septa are thin, tapering slightly towards axis. In early growth stages, major septa extend almost to corallite axis (Pl. XII, fig. 8), but in maturity they are somewhat withdrawn extending 0·7–0·8 of corallite radius (Pl. XII, fig. 5) and numbering 20–22. Minor septa reach 0·35–0·5 of length of major septa.

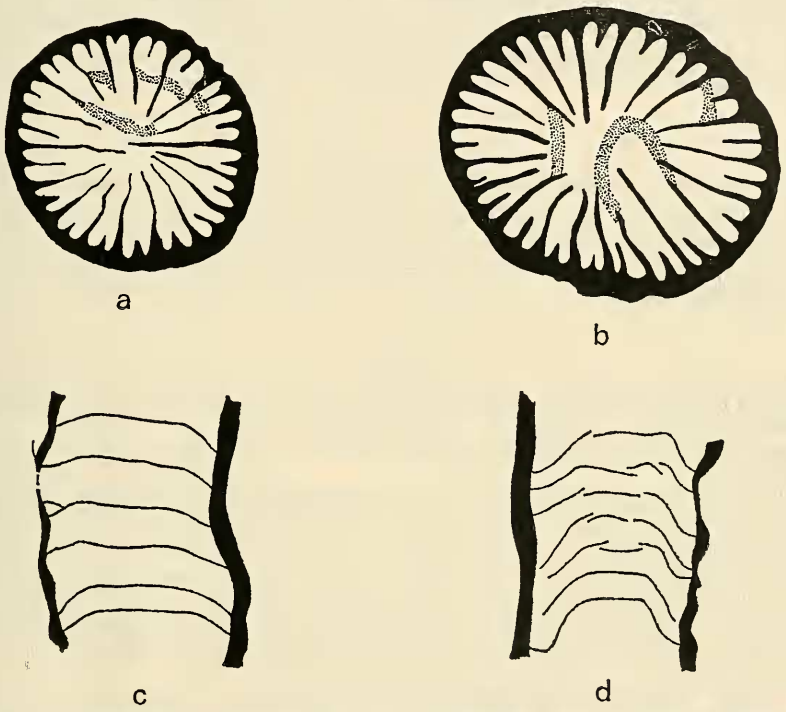

Fig. 7. *Palaeophyllum oakdalensis* sp. nov., Catombal Park Formation, Mumbil area. a. SUP 74233, paratype, transverse section of immature specimen, ×6. b. SUP 74229b, holotype, transverse section of mature specimen, ×6. c. SUP 74231b, paratype, longitudinal section showing most commonly observed tabular shape, ×4. d. SUP 74230b, paratype, longitudinal section showing rarely developed highly arched tabulae, ×4.

Tabulae are generally flat with weakly downturned edges. Degree of downturning is very variable, some barely showing this feature while others are markedly domed (Text-figs 7c, d). Tabulae are only rarely incomplete. Spacing of tabulae is quite variable. In a few examples they are closely spaced (0·1 mm) and grouped in series (Pl. XII, fig. 4) but in general they are evenly and widely spaced, average 0·8–1·2 mm. Axial depression of tabulae is very weak or more commonly absent.

Remarks. Strusz (1961) originally described this form as belonging to *P. rugosum* Billings, 1858, the Upper Ordovician type species from Quebec. However, from the descriptions of Hill (1961) it may be clearly distinguished from *P. rugosum* by having parricidal increase, longer minor septa and tabulae lacking a marked axial depression. Webby (1972, p. 152) also recognised the distinction of Strusz's form from the type species.

Species of *Palaeophyllum* have not been commonly recorded from the Silurian and the only forms of comparable age to *P. oakdalensis* are *P. multicaule* (Hall, 1852) redescribed by Oliver (1963), and *Palaeophyllum* ? sp. G of Merriam (1972). *P. multicaule* is represented in the Lockport Dolomite (late Wenlock-late Ludlow) of Lockport, New York, and may be distinguished from *P. oakdalensis* in having smaller corallite diameter, longer major septa and shorter minor septa. *Palaeophyllum* ? sp. G occurs in the Gazelle Formation (Ludlow) of the Klamath Mountains, California. It has flattened tabulae comparable to some specimens of *P. oakdalensis* but differs in having shorter septa, particularly in early growth stages (Merriam, 1972, Pl. 2, figs 9, 10). In its short septa (approximately 0·5 of corallite radius), *Palaeophyllum* ? sp. G would appear to be intermediate in character between typical *Palaeophyllum* and *Pycnostylus* Whiteaves.

None of the previously described Australian representatives of *Palaeophyllum* (Webby, 1972) bear any close similarities to *P. oakdalensis*.

Acknowledgements

The author is grateful to Associate Professor B. D. Webby for critical review of the manuscript and to Mrs. A. Byrnes for providing both material for study and unpublished information about the stratigraphy of the Mumbil area.

The project was supported by a Macleay Fellowship of the Linnean Society of New South Wales.

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EXPLANATION OF PLATES

Plate viii

Figs 1–5. *Holmophyllum colligatum* (Hill), Bowspring Limestone, Hatton's Corner, Yass district, AM 704, holotype, ×5. 1–2. transverse sections. 3–5. longitudinal sections.

Figs 6–9. *Holmophyllum struszi* sp. nov., Catombal Park Formation, Oakdale Anticline, Mumbil area. 6. SUP 74220c, holotype, transverse section, ×4. 7. SUP 10289, paratype, transverse section showing recrystallised septal spines, ×25. 8. SUP 10289, paratype, transverse section, ×3. 9. SUP 74220g, holotype, longitudinal section, ×3.

Plate ix

Figs 1–3. *Holmophyllum struszi* sp. nov., Catombal Park Formation, Oakdale Anticline, Mumbil area. 1. SUP 74220d, holotype, longitudinal section, ×4. 2. SUP 74220k, holotype, longitudinal section, ×4. 3. SUP 74220h, holotype, longitudinal section, ×4.

Figs 4–7. *Holmophyllia maculosa* sp. nov., Catombal Park Formation, Oakdale Anticline, Mumbil area, ×5. 4. SUP 40261d, holotype, longitudinal section. 5. SUP 40261e, holotype, longitudinal section. 6. SUP 40261c, holotype, longitudinal section. 7. SUP 40261a, holotype, transverse section.

Fig. 8. *Holmophyllia* cf. *simplex* (Lewis), Narragal Limestone, Mumbil area, ×3. SUP 74228, tangential longitudinal section.

Plate x

Figs 1–7. *Holmophyllia* cf. *simplex* (Lewis), Narragal Limestone, Oakdale Anticline, Mumbil area. 1. SUP 39184a, transverse section showing rhabdacanthine septa, ×25. 2. SUP 39184c,

longitudinal section showing partially fused septal spines on corallite wall, ×25. 3. SUP 39184c, longitudinal section, ×3. 4. SUP 39184c, longitudinal section showing fused septal spines on corallite wall, ×25. 5–7. SUP 39184a, transverse sections of different corallites, ×7.

Figs 8–10. *Coronoruga dripstonense* Strusz, Narragal Limestone, Mumbil area, ×3. 8. SUP 11103f, paratype, transverse section of early growth stage. 9. SUP 11103a, paratype, longitudinal section. 10. SUP 11212, paratype, longitudinal section showing sclerenchymal coating on tabulae.

Plate xi

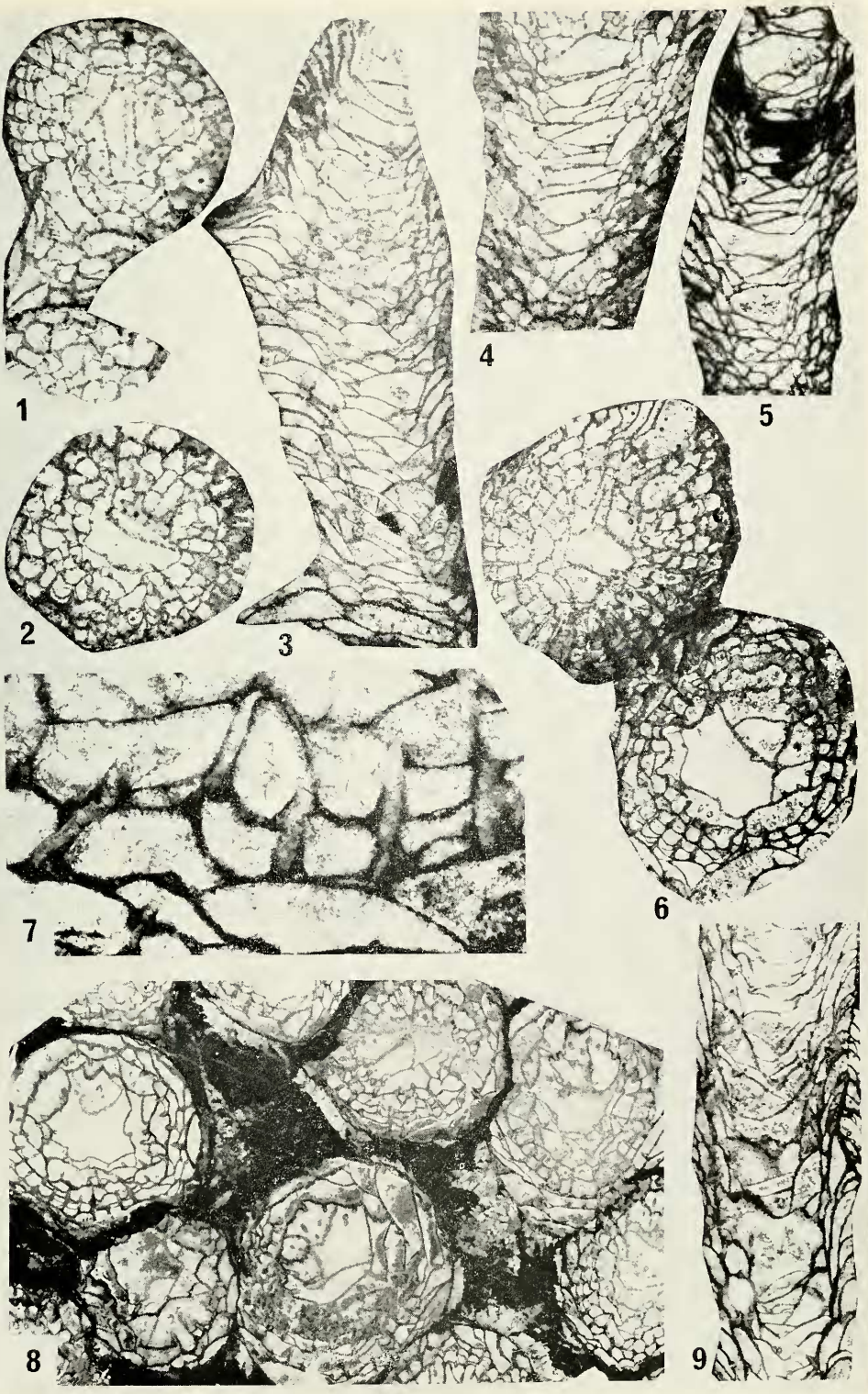
Figs 1–3. *Coronoruga dripstonense* Strusz, Narragal Limestone, Mumbil area, ×3. 1. SUP 11215, paratype, transverse section. 2. SUP 11198a, paratype, transverse section. 3. SUP 11103b, paratype, longitudinal section showing sclerenchymal coating on dissepiments.

Figs 4–6. *Pilophyllum multiseptatum* (Strusz), limestone lens in Barnby Hills Shale, Mumbil area. 4. SUP 11099f, holotype, transverse section, ×4. 5. SUP 11099e, holotype, longitudinal section showing lateral increase and sclerenchymal coating of dissepiments of incomplete corallite at right, ×3. 6. SUP 11099h, holotype, transverse section, ×4.

Plate xii

Figs 1–3. *Pilophyllum multiseptatum* (Strusz), limestone lens in Barnby Hills Shales, Mumbil area. 1. SUP 11099g, holotype, longitudinal section, ×4. 2. SUP 11099d, holotype, longitudinal section, ×3. 3. SUP 11099i, holotype, transverse section of early growth stage, ×4.

Figs 4–8. *Palaeophyllum oakdalensis* sp. nov., Catombal Park Formation, Oakdale Anticline, Mumbil area. 4. SUP 74235, paratype, thin section (note variation in tabular spacing), ×3. 5. SUP 74229a, holotype, thin section, ×4. 6. SUP 74229e, holotype, longitudinal section, ×4. 7. SUP 74229f, holotype, longitudinal section, ×4. 8. SUP 74233, paratype, transverse section (note quadripartite offsets at right), ×4.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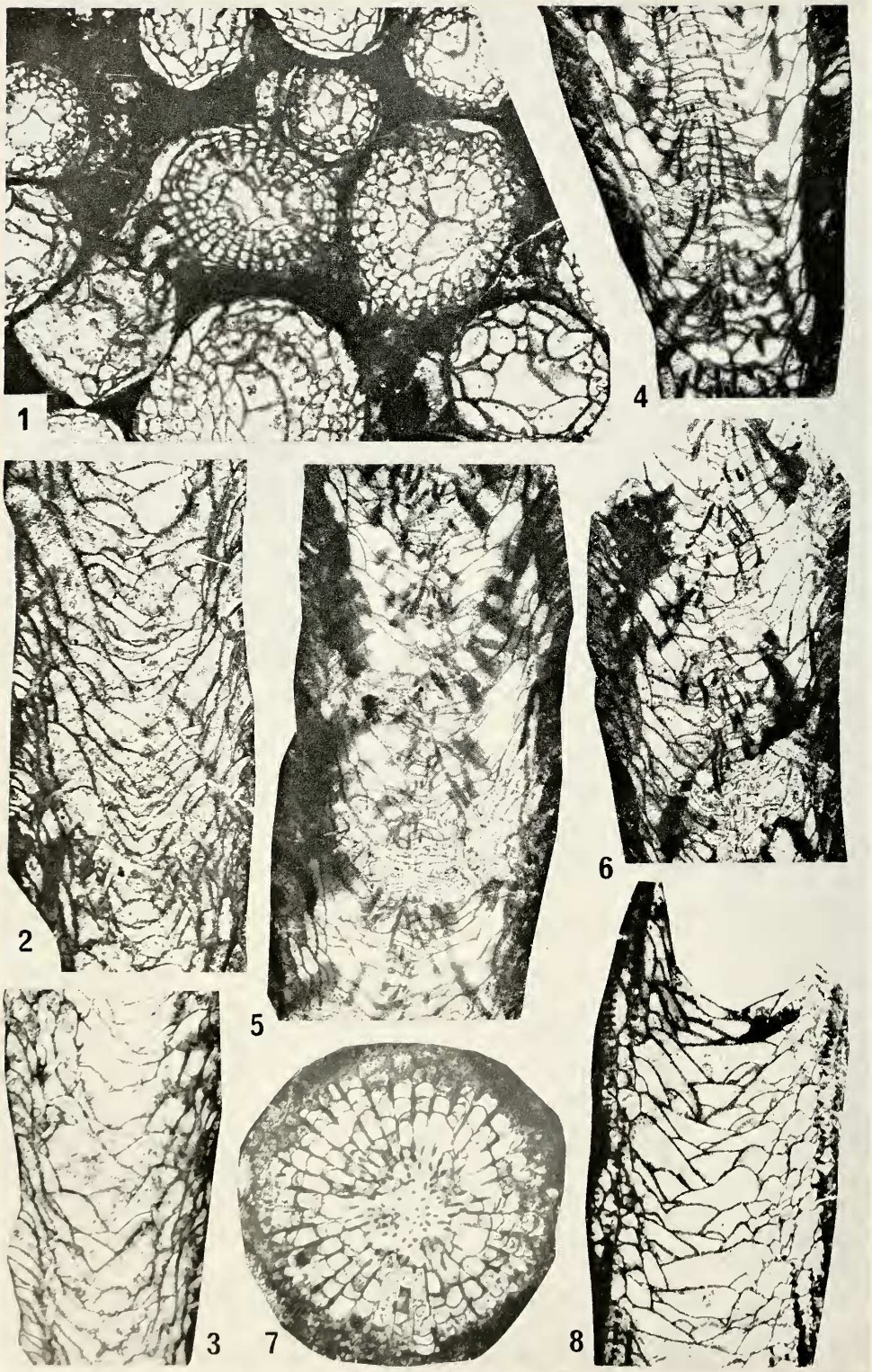
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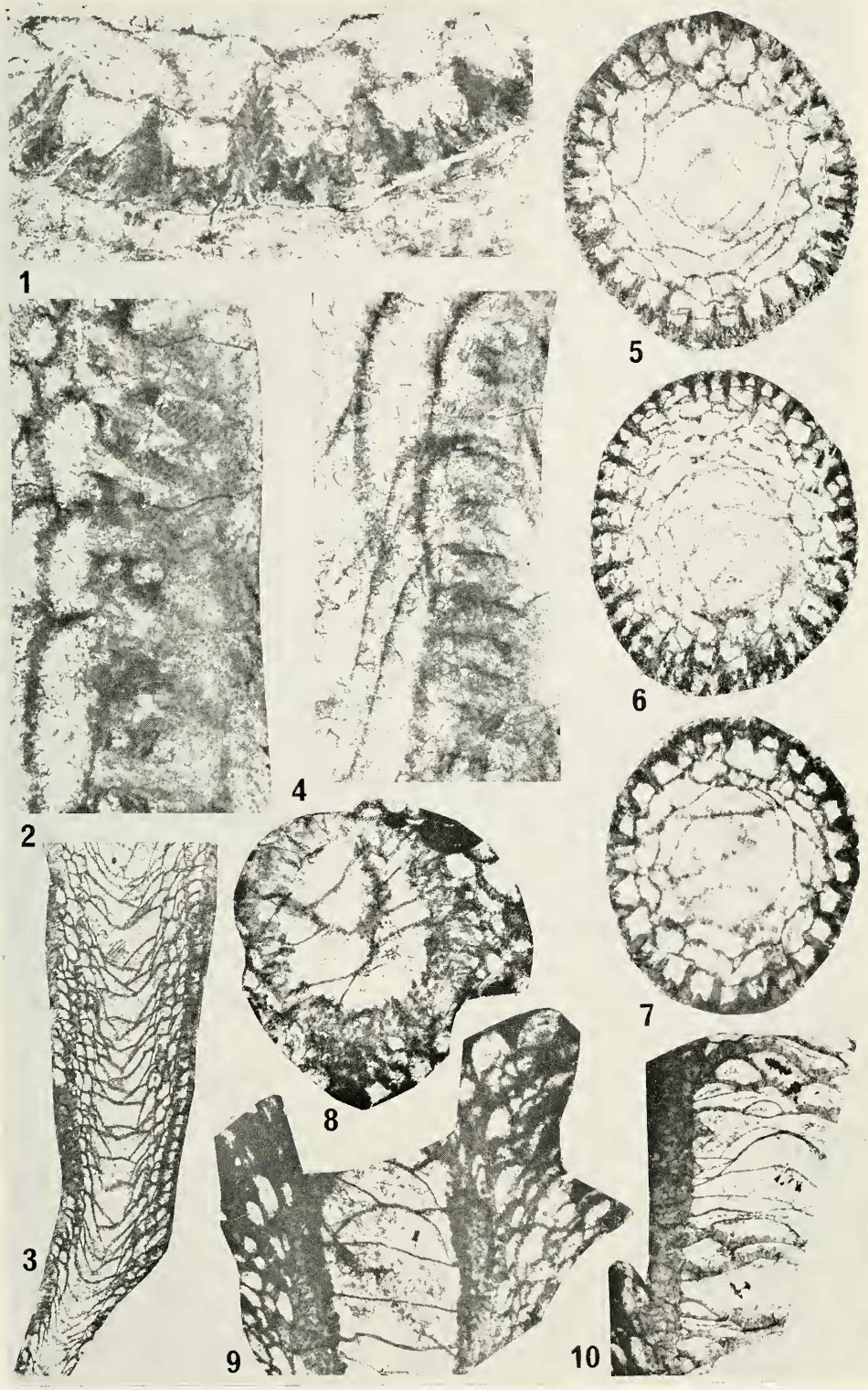
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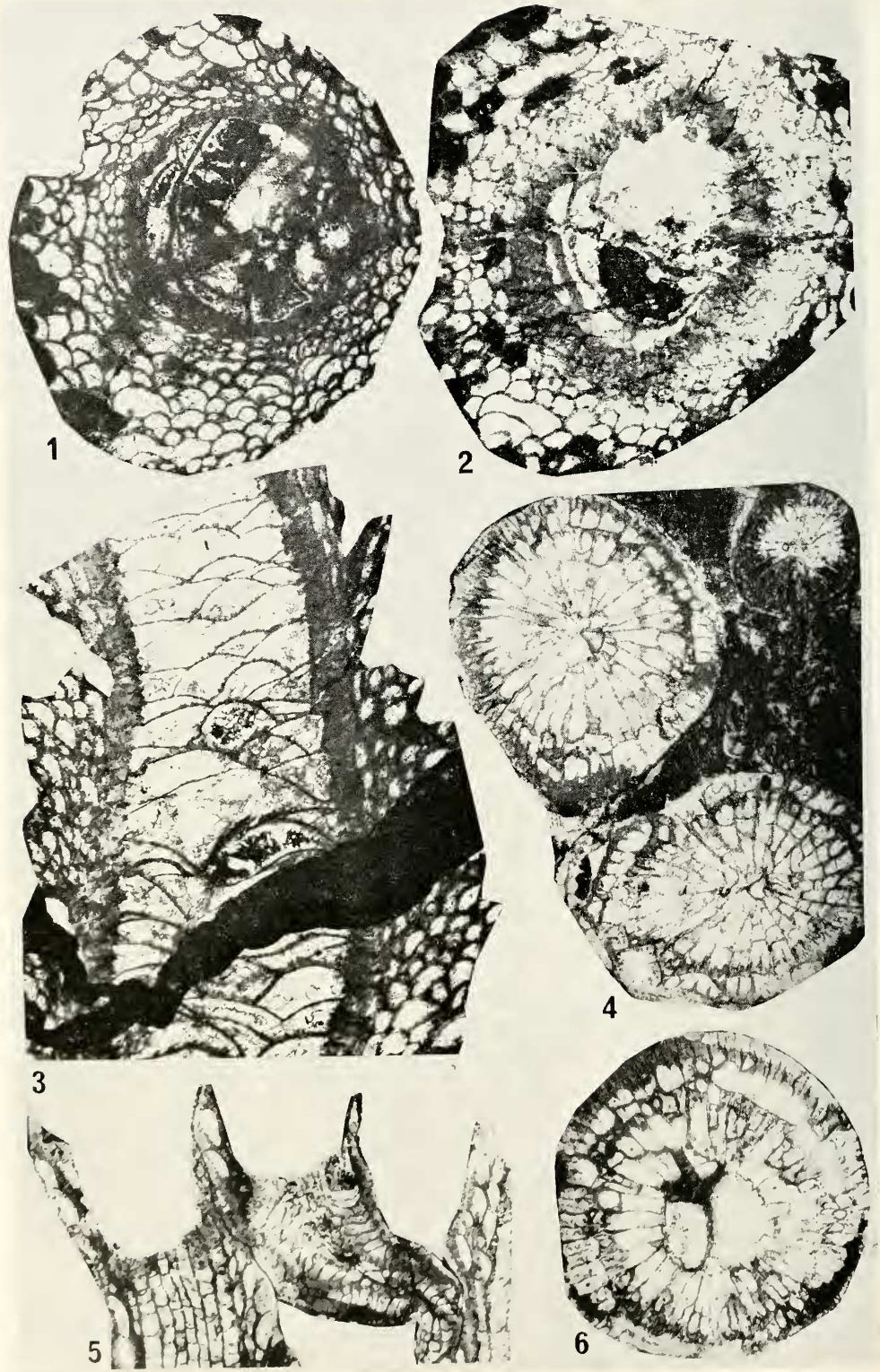
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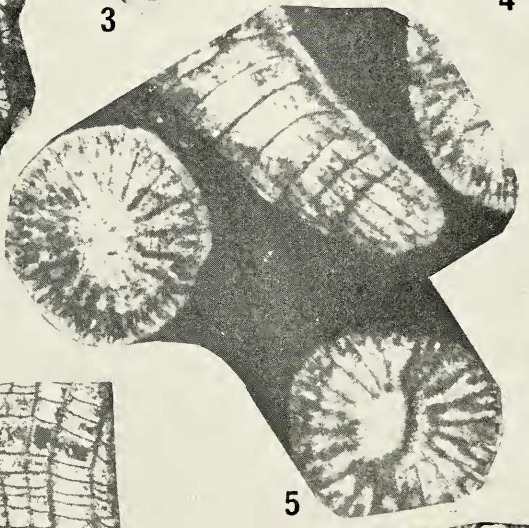
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